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CONTENTS

Marlow Ediger 1 Philosophy in the Science Curriculum

A. C. Pachaury 5 Length conservation in 7, 8 and 9 year-old Children

M. K. Srivastava 12 Shaping Science Education for Development in Madhya Pradesh

S. N. L. Bhargava 20 Learning Science Through Observing Process

N. N. Prahallada 24 Integration of School Physics and Technology Education

Mark F. Brown 27 Catabolin : the clue to Arthritis ?

H. O. Gupta 32 On the Conceptually Difficult Matter in Chemistry

36 SCIENCE NEWS

43 BOOK REVIEWS

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Philosophy in the Science Curriculum

MARLOW EDIGER

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THERE ARE numerous philosophical schools of thought available in developing lessons and units. Certainly, teachers and supervisors need to study and analyze diverse philosophies. Ultimately, a philosophy needs to be developed which guides students to

1. perceive interest in science.
2. achieve meaningful learnings.
3. attain purpose or reasons for learning.

A Project Method

Emphasizing project methods in teaching science stresses active, not passive learners. The involved learner with teacher guidance selects sequential projects to complete. Thus, hopefully, this student will perceive purpose in working on the project. He/she was involved in selecting, rather than the teacher solely determining which goals a student is to attain.

Once, a project has been selected, such as developing a windvane in a unit on "Weather—How It Affects us", the student needs to plan its sequential steps through completion. The learner must be clear on materials and equipment needed in making the windvane. Also, reference sources will need to be used to gain increased knowledge of windvanes.

Next, the student must do the actual work in the construction activity. Actually utilising the materials, equipment, and reference sources are involved in carrying out the construction activity. Definite skills are needed in developing and completing the project.

The end project needs appraising by students with teacher guidance. The windvane may be evaluated in terms of working properly, being neatly made, showing effort in its making, and being durable. The teacher may also discuss with the student how the windvane could be improved upon in terms of quality.

A project method does not advocate

1. teachers selecting what (the objectives) students are to learn, nor the means (activities and experiences) of learning.
2. a strict subject centered curriculum.
3. cognitives objectives, to the exclusion of affective and psychomotor ends.
4. lecture and heavy use of explanations in teaching.
5. expository approaches in the instructional arena.

Shepherd and Ragan wrote the following, which the writer believes, follows tenets of the project method:

> Progressive educators believe that children learn best when the material meets some recognized need, not when they are forced to memorize meaningless material; that children should have many contacts with

concrete objects, places, and people, as well as with books and other printed materials; that the school should be concerned with children's physical, emotional, and social development, as well as with their mental development. They believe that the school should foster freedom, not license; that subject matter should be a means rather then an end in the educative process; that understanding rather than fear should be used to motivate acceptable behaviour; and that purposeful activity is more productive than imposed routine.

Programmed Learning

Programmed learning can be emphasized in either textbook form or computer assisted instruction (CAI). In a unit on "Weather—How It Affects us", the programmer decides objectives and sequential activities for students to encounter. A small amount of knowledge is presented in the programmed book or on a screen in CAI. The involved student reads the content and then responds to a completion item. To check each answer in a programmed book, the student uncovers the correct answer as given by the programmer. Immediately, the student knows if he/she is right or wrong. If correct, the learner is rewarded. The student who responded incorrectly sees the correct answer and is also ready for the next linear item in programmed learning. Read, respond, and check are used again and again by the learner in acquiring programmed content in textbook form.

With computer use, the student, as was noted above, reads several selected sentences, and types in a response using the keyboard at the terminal. After responding (typing the chosen response), the screen may have the word "correct" or if an incorrect response was given "try again". If the response given is again incorrect, the software used in the computer will provide the correct answer on the screen. This student, as well as the successful responders, are ready for the next linear programmed item in CAI. The same sequence follows in using computerized instruction—read, respond, and check.

Programmed learning does not emphasize :

1. teacher-pupil planning of objectives, learning activities, and appraisal procedures.
2. students sequencing their own learning activities within a flexible framework. Rather, the programmer orders experiences for students.
3. an activity centered curriculum in which the student plans, develops, and completes a project.
4. students learning to make decisions and choices.
5. delays in which learners wait to find out correct or incorrect responses were given.

Pertaining to programmed instruction, Morris and Pai wrote the following involving the thinking of B. F. Skinner:

> As Skinner cautions us, in programing it is important that the learners "understand" each step before they move on to the next. This means the learners stay in one stage until they master what they have to learn to move on to the next stage. In principle, however, programmed instruction is more than a matter of shaping terminal behaviour simply by dividing it into smaller units and reinforcing them one by one. A subject, or a skill such as critical thinking, is more than a mere aggregate of individual responses, for the smaller units are related to each other in such a way that they, as a whole, possess varying degrees of coherence and consistency. Moreover, in programmed instruction each new unit of learned behaviour should add to already established behaviours in a

cumulative way so that terminal behaviour can be reached progressively.

Humanism and Science

Humanists advocate that students learn to make decisions. Thus, alternative learning activities are in the offing from which the student may make sequential choices. The following learning centers are provided as examples from which students may choose to work at: construction; experimentation and demonstration; textbook and workbooks; programmed learning creative experiences; and library/trade books. Each center may contain a task card describing activities learners individually or in committees can select to pursue. An adequate number of tasks must be in the offing so that the involved student might choose from among alternatives. Undesired tasks may be omitted. Optimal progress should be a relevant end result if the learner may truly sequence his/her own progress.

Humanism does not advocate

1. teacher selecting ends, means, and appraisal procedures for students.
2. a structured curriculum which leaves few or no options.
3. measurable objectives for student attainment.
4. an adult centered science curriculum.
5. teachers sequencing experiences for learners.

Rogers wrote:

Commitment is the emerging and changing total direction of the individual, based on a close and acceptant relationship between the person and all of the trends in his life, conscious and unconscious. Unless, as individuals and as a society, we can make constructive use of this capacity for freedom and commitment, mankind, it seems to me, is set on a collision course with fate . . . .

A part of modern living is to face the paradox that, viewed from one perspective, man is a complex machine. We are everyday moving toward a more precise understanding and a more precise control of this objective mechanism which we call man. On the other hand, in another significant dimension of his existence, man is subjectively free; his personal choice and responsibility account for the shape of his life ; he is in fact the architect of himself. A truly crucial part of his existence is the discovery of his own meaningful commitment to life with all of his being.

Conclusion

There are numerous recommended philosophies from which science teachers might benefit in selecting objectives, learning activities, and evaluation procedures. Among others, these include a project method, programmed learning, and humanism. Project methods and humanism allow considerable flexibility in developing the science curriculum. Programmed learning is highly structured and permits little/no input from learners in developing lessons and units.

Teachers need to guide students to achieve optimally in interests, meanings, and purposes in the science curriculum.

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Length conservation in 7, 8 and 9-year-old children

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GENEVAN RESEARCH on children's thinking has been conducted under the rubric of genetic epistemology. According to Piaget and his collaborators, the concepts of conservation are acquired in an invariant chronological order. Length is conserved around 7-8 years at age, while discontinuous length is conserved at age 9 (Inhelder, 1963 ; Piaget et al., 1964). Indian children show anamolous underperformance in the attainment of quantity concepts (Pachaury, 1974, 1975, 1976 a, 1979 a, b, 1981 ; Pachaury and Masih, 1975) ; horizontality and verticality (Pachaury, 1983). Delay in the attainment of length conservation has been reported by Al-Fakhri (1973) ; Opper, 1971 ; and Lovell et al. (1962), for the Iraqi, Thai and British children respectively. The aim of this study is to investigate : Whether Indian subjects conserve continuous and discontinuous lengths at ages parallel to the Genevan children or not.

METHOD

Subjects

Commensurate with the aim of the study, children in the age range 6 to 9 years formed the sample. These children belonged to the middle socio-economic status. Demographic characteristics of the subjects are as shown in the accompanying table.

TABLE 1

DEMOGRAPHIC CHARACTERISTICS OF THE SUBJECTS

Age	*X Age in mo*	*S.D. in mo*	*Number of subjects Boys*	*Girls*
6 : 0·6 : 11	77.92	2.82	24	19
7 : 0-7 : 11	89.82	3.12	40	18
8 : 0-8 : 11	98.52	3.68	16	8
		Total	80	45

Procedure

Each child was individually interviewed. As soon as the child entered the room he/she was made to sit confortably in the chair with a table in front of him/her. The experimenter set opposite to the subject. In order to establish rapport with the child, the experimenter introduced himself and then asked the subject's name, age, number of siblings etc. The medium of interview was Hindi, the mother tongue of the students.

Tasks

Materials, initial configuration and transformation are as depicted below :

Materials — Initial Configuration — Transformation

(a) Continuous Length

1. Two unsharpend pencils of same colour and equal lengths.

(b) Discontinuous length

2. Ten matchsticks

3. Eight matchsticks

4. —do— —do—

5. Seven matchsticks.

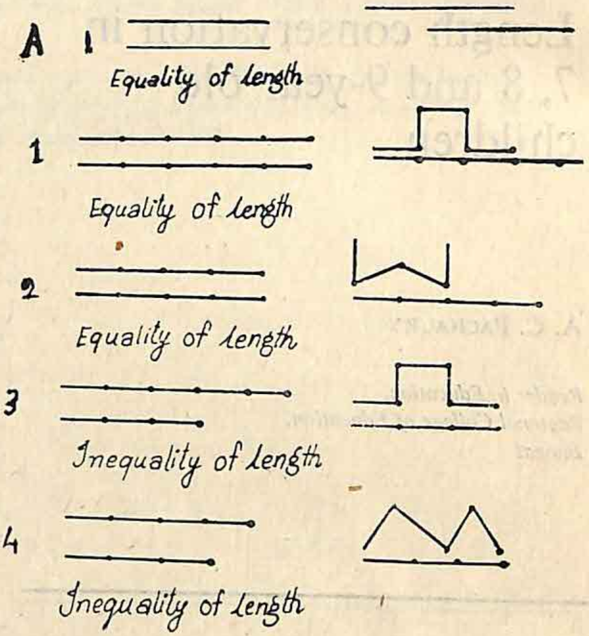

TABLE 2

PERCENTAGE OF SUBJECTS ATTAINING CONTINUOUS AND DISCONTINUOUS LENGTH CONSERVATION.

Stage : *Age—Group*	L_1	L_2	L_3	L_4	L_5
1 6:0—6:11	—	03.00	—	—	—
7:0—7:11	—	—	—	—	—
8:0—8:11	03.00	—	—	—	—
2 6:0—6:11	86.00	81.00	82.00	83.00	79.00
7:0—7:11	60.00	60.00	60.00	55.00	62.00
8:0—8:11	63.00	62.00	50.00	50.00	46.00
3 6:0—6:11	14.00	16.00	16.00	17.00	21.00
7:0—7:11	40·00	40.00	40.00	45.00	38.00
8:0—8:11	34.00	38.00	50.00	50.00	54.00

Task I : Continuous Length

Both the pencils were shown to the subject. He/She was allowed to handle them. First, equality of length was established. Then both the pencils were laid parallel in the middle of the table. This was followed by a series of questions by the experimenter.

E : Are the lengths of the pencils equal ?
S : Answered.
E : Shifted one of the pencils ahead about 3.0 cms. Are the lengths of the pencils equal now ? Is or one longer (shorter) than the other ?
S : Answered.
E : Why ?
S : Explained his/her reasoning.

Complete stenographic notes were taken by the experimenter on all tasks and for each child separately. Tasks, 2, 3, 4, and 5, were randomly administered. However, the sequence of questions remained invariant. First question elicited equality or inequality of the initial configuration in yes or no. The second question elicited judgment response also in yes or no and the third question elicited explanation.

Scoring

Each question answered correctly by the subject was scored one. All wrong responses were scored zero. Explanations were scored for identity, compensation by reciprocity, and cancellation through reversibility (Inhelder et al, 1974; Pachaury, 1974, 1975, 1976 a, 1979 a,b, 1981). Depending on the S's responses, each child was assigned to one of the three stages :

Stage I : All the questions and explanation were incorrectly answered, i.e. *non-conserver*.

Stage II : Sometimes correctly answered a question and at others incorrectly answered the question and incorrect explanation, i.e., *transitional*.

Stage III : All the questions were correctly answered together with appropriate explanation, i.e., *conserver*.

Results

Table II shows the percentage of S/s attaining stages 1, 2 and 3 on conservation of continuous and discontinuous lengths on tasks I to V.

(a) Conservation of Continuous Length (L_1)

3% of 9-year-olds of this sample were non-conservers of continuous length. None of the subject of 7 or 8-years of age was non-conserver on this task. However, majority of the Ss were in *transitional stage* (63% to 83%). Fourteen per cent of 7-year-olds were conservers of this task. For 8 and 9-years the percentage was 40 and 34 respectively.

(b) Conservation of Equality of Discontinuous Length (L_2)

3% of 7-year-olds were non-conservers of equality of discontinuous length. None of the subject of 8 or 9-years of age was non-conserver on this task. As for continuous length conservation, on this task too, majority of the Ss were in transitional Stage—60% to 77%. Sixteen per cent, 40% and 38% of 7, 8 and 9-year-olds conserved this task respectively.

(c) Conservation of Equality of Discontinuous Length (L_3)

2% of 7-year-olds were non-conservers on this task. None of the subject of other ages was non-conserver. However, as for tasks L_1 and L_2, on this task as well, majority of the Ss were in *transitional stage* (50% to 82%). Sixteen per cent, 40% and 50% of 7, 8 and 9-year-olds were conservers on this task respectively.

(d) Conservation of Inequality of Discontinuous Length (L_4)

None of the subject of either ages of the sampled population was non-conserver on this task. However, as for tasks I to III, on this task also, majority of the Ss were in *transitional stage* (50% to 83%). Percentage of Ss conserving this task were 17, 45, and 50 for 7, 8 and 9-years respectively.

(e) Conservation of Inequality of Discontinuous Length (L_5)

On this task too, as for task IV, none of the subject of either ages was non-conserver. Here again, as for the other four tasks, majority of the Ss were in *transitional stage*—46% to 79%. Twenty-one per cent of 7-years; 38% of 8-years; and 54% of 9-years conserved this task.

Discussion

Using the 75% criterion, the Indian Ss of 7-8 and 9-years of age of this sample, show delay of at least 3 to 4 years in the attainment of conservation of continuous and discontinuous lengths. They compare favourably with their Iraqi (Al-Fakhri, 1973), Thai (Opper, 1971) and British (Lovell, et al. 1962) peers, as delay of 2 to 4 years in the attainment of length conservation has been reported from these cultures. Algerian unschooled children conserved length between 10-12 years of age, thereby showing delay of about 4-5 years (Inhelder et al., 1974). Judged against these observations 3 to 4 years delay in the attainment of these length concepts by the Ss of this study, does not seem to be very much unusual finding. Educational and cultural milieu of Algerian, Iraqi, Indian and Thai children do not nurture development of mental operations needed for the conservation of length concepts. Learning environment and teaching strategies like book reading and recitation, presentation of the information by the teachers and stress on memorization, by and large, are not helpful instructional procedures for the development of operatory schemes necessary for the acquisition of length conservation investigated in this study. If conservation of length is to be developed in children, one would like to know the requisite operatory schemes which underlie it. Unlike quantity conservation, "length conservation involves a complex process of differentiation in one-dimensional quantity inside a stable spatial framework. Infact, interfigural comparisons have to be made with reference to a system of implicit co-ordinates (Plaget and Inhelder, 1964)". It is only by the age nine or ten that children clearly differentiate displacement and elongation (Piaget, 1971). These operatory schemes involve construction of uni-dimensional quantification together with dimensional valve of the units of length. "Length is conserved when its quantificable attribute is internalized and this construction implies an operatory structure of units of length (Inhelder, et al., 1974)".

Implications for Science Teaching.

Having identified the operatory schemes, which underlie conservation of length concepts, we should reflect on how to go about for their development in children. Our educational system is predominantly of Cultural Transmission-Behaviourist type, or at best here and there having faint splashes of Romanticism-maturationist tinge. From the genetic epistemology point view, these twin—theories of education do not take us beyond *'figurative knowing'*. While conservation implies development of operatory schemes like identity, dimensional compensation and reversibility by reciprocity. Development of these operatory schemes is essentially an interactive process between the individual and the objective world. One seldom acquires conservation by being told about it or having read in a book. It requires logical necessity, which comes through active process of construction by the individual. Operatory knowledge comes through transformation, acting upon and structuring the information. In Piaget's view, knowledge :

> is Not being absorbed passivity from the environment, is Not being performed in the child's mind and ready to emerge as child matures, but It's being constructed by the child through his interactions between his mental structures and his environment.

Hence, passive methods (Pachaury 1979 C) lead to *congnitive passivity* and do not help in the development, refinement, extension and coordination of mental structures. Inquiry centered classroom experiences are essential for their progressive differentiation and consolidation. This approach provides self-regulatory mechanism for learning by the children. Piaget's theory has greatly influenced elementary science courses as well as at collegiate level. Two aspects of Piaget's theory that have strongly affected the educational practice are: the stage model and the equilibration-model. Arguing about utility of Piaget's stage-model, Renner and Abraham (1982) observe:

> Piaget's stage model has been used to support laboratory and 'hands-on' approaches to science instruction and to justify the emphasis on teaching concepts which can be learned through experience—concrete concepts. The stage model has also been used as the theory base for instructional procedures that encourage intellectual development and *increase content understanding*. Those procedures are called *concrete instructional procedures* (pp. 228-229).

Piaget's Equilibration – Model

Piaget has described how comprehension of concepts is attained through the process of equilibration. This process abstracts and integrates information into new conceptual structures. Equilibration encomphases twin processes of assimilation and accommodation. Learning begins with assimilatory process. In this process the learner internalizes incoming stimuli into the prevailing mental structures resulting in either concept development or refinement and/or concept elaboration. At times prevailing mental structures are unable to assimilate incoming information. This leads to *disequilibrium*. The mental structures, therefore, must change in order to incorporate the discrepant event. This is, in Piagetian sense, the process of accommodation. Equilibrium is restored as soon as accommodation is completed. "The developmental model states, therefore, that learning is the process of assimilation, accommodation and organization and the entire sequence is called *functioning*. Functioning, however, begins with assimilation and without it, none of the other processes can take place" (Renner and Abraham, 1982). Based on the equilibration-model of Piaget, Science curriculum Improvement Study Project with headquarters at University of California, Berkeley, has designed and tested what they call *'The Learning Cycle Approach'* to school science instruction. A general pattern of teaching that has been followed, comprises of: *exploration, Conceptual invention* and *expansion of the idea*. By exploration is meant, "initial direct physical and mental contact with natural world. This experience is essential if something more than verbam behaviour is to be learned. If real understanding is to be achieved, real contact with the world has to be provided" (Lawson, 1975). Exploration is essentially an assimilatory process. In the second phase, based on the *exploratory experiences*, children *invent* the theme or the concept to be studied. It corresponds to the process of accommodation. This phase is followed by discovery, where children discover subordinate concepts of the *theme* or the concept through activity procedures. This too would be an accommodative process. The 'learning cycle' enables children not only to discover facts and construct knowledge but also provides reinforcement and enlargement of the content of the concept.

Children exposed to SCIS programme achieved a higher level of reasoning as well as higher achievement on the process tests, than students studying science through traditional cookbook and information — varification procedures (Renner et al., 1973). A direct test of the effectiveness of science learning by the children through *'Learning cycle'* comes from the findings of Scheider and Renner 1980. Research evidence also strongly supports *'equilibration model'* as a potential source of development of operatory schemes necessary for the development of conservation concepts like quantities, length, number and class-inclusion (Inhelder et al., 1974). On the issue of use Piagetian researches, Bearison (1975) has rightly observed that:

> The relevance of Piaget's theory to education is to respect each child's stage of cognitive development by achieving the optimal match between modes of instruction and modes of thought.

In case we would really like to respect the child's developmental nature, science curriculum has to be developed keeping in view three things—the developmental characteristics of the learner, the structure of science and its modes of inquiry. In order to minimize mis-match among these three facets, ad hocism as prevails in science curriculum development to-day, has to be replaced by *'field tested'* procedures. The author is ignorant about any science curriculum that has been developed on the suggested lines in our country. However, it is sincerely hoped, that curriculum developers would seriously consider the merits of the field tested curricula backed by *'the learners' level of development, the structure of science and its modes of inquiry'* (Pachaury, 1976 b, 1978) .

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Shaping Science Education for Development in Madhya Pradesh

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SCIENCE EDUCATION in present context includes the term "Education in Science". "Education about Science" and "Education through Science". It should therefore include the teaching of content (knowledge, scientific methodology and applications of science), the social context of science and encouragement of acquisition of skills and attitudes which are of value in relation to educational goals. On the basis of world wide educationists views, J.F. Kerr has published a list of sixteen educational goals related to cognitive and effective domains of the child. To achieve a goal, a number of aims be laid down and similarly an aim may be associated with a number of behavioural changes (objectives) in child.

The curriculum is designed in relation to the National goals i.e. it must reflect the ways of life, aspirations and the needs of the people. It must act as an instrument of social change. In science the domains for curriculum were decided with a view to increase productivity and rational outlook. They are as under:

(i) Experimental Science
(ii) Science and its Applications
(iii) Science and Technology
(iv) Science and Society etc.

To develop scientific literacy in adults the programmes based on, cultural, civic and survival aspects of human life are to be designed.

The National Science Foundation, USA has published in 1980, a report named as "Project Synthesis". This has critically examined the science programmes run in the schools and recommended a few reforms to bridge the gap between the actually run programmes and the desired programmes. The recommendations are as under :

(1) Reformulation of goals of science education.
(2) New conceptutalization of science curriculum with a foci on student directed experiences.
(3) New Programmes for Pre-service and In-service training of teachers. The effort for their continual growth and peer interaction need to the high-lighted.
(4) Concrete examples be used to learners.
(5) Translating new research programmes into practice.
(6) Evaluation to encourage self assessment and decision making etc.

The gist of these experiences accumulated after several research projects, will help in devising the strategy for developing science education programmes in our State.

Science Education in Madhya Pradesh

Madhya Pradesh is centrally located with largest land area and scattered population in it. It is rich of forests, water-falls and reserves of minerals underneath. About forty percent of its population lives in remote villages and is tribal. In Nineteen Sixties, the schools were opened in these areas and the first generations were given opportunity to attend formal schooling in science teaching in primary and middle schools.

In nineteen seventies in collaboration with UNICFF and NCERT, the science teaching was introduced in primary and middle schools which has now reached to the universalization stage.

To enable teachers to handle science courses, a gigantic task of training 1,20,000 teachers (with no background in science) was under-taken in mid seventies. This in-service course was of one year duration, out of which sixty working days were spent on conducting science activities (self study) and then using them in teaching learning situations. Each teacher was given a set of material covering forty units of primary and middle stage. Science kits were provided to some of the schools. All the science textbooks prescribed by NCERT, were mended according to the needs of the State. This Science Education Programme was evaluated in 1976. It was observed that our achievements were worth-while quantitatively whereas poor qualitatively. It has pointed out that :

(i) Our courses are not meeting out the demands of daily life.

(ii) Our investment in science is meagre and that too unplanned.

(iii) Our teachers are not fully benifited by the training and their techniques of teaching are out-dated.

(iv) Our resources for teaching science in schools are almost negligible.

(v) Our supervision work lacks humanistic touch.

It was therefore decided to introduce environmental studies at primary level. The resources will be drawn from the natural and social environment of the children. The purpose is to enrich their experiences, with the keen observation of the environment. The curriculum provided flexibility in developing instructional material according to the specific needs of an area.

In our state, after indentifying the regional needs the various sets of textbooks, teacher-guides were developed. More and more stress is laid on performing the activities—the resource material includes, the flash cards, the locally available material's collection etc. The communicative modes of using poems, stories, field strip etc. are used in classroom teaching learning process. The examinations are also to be reformed. An awareness need to be developed in teachers to relate physical events in learning science.

Inspite of all these efforts the science education is like a rat race in the social jungles of Madhya Pradesh.

Educationists view that:

"Science is what the scientists do". So allow the child to be a scientist for a day i.e. let him learn the processes of science.

Wordsworth has said:

"Comeforth into the light of things
Let Nature be your teacher"

Scientists questions what?, How? of Nature while technologists manupulates Nature.

The role of primary teacher is to take account of findings of these two and then help the children in learning new knowledge related to their old one. For this the primary teacher need not be a great store house of scientific knowledge himself. Therefore he should not fear for it. As a matter of fact he should play the role of the teacher of a child not the science teacher.

In Middle School's (11^+ to 14^+)

The objective is to introduce science as physical and life science. At the same time environmental studies, nutrition health and population education should also be attended for, so that science could be related meaningfully to life.

At present in our state the science is taught as separate discipline e. g. physics, chemistry, biology. It is the weakest link in science teaching between the primary and higher secondary school in the state. It is observed that:

(i) The textbooks are abstract in nature and are tough.
(ii) The resources are null and void.
(iii) The science teachers are incapable to teach science using experiments.
(iv) The examinations are routined and memory based.

Science at this stage needs evidence. The observations and experimentation are crucial to it. According to Harald Jensen:

"If you can not show it, don't teach it".

In Hoshangabed district of M. P., a project to teach science with inquiry approach is conducted for the last ten years. Their results are encouraging.

Researches in the field of science education advocates teaching integrated science at this level, because children may get exposure to a broad spectrum of subjects like, Physics, Chemistry, Biology, History, Geography and Languages etc. Integrated science will also help in:

(i) expanding the idea of environmental studies to higher level.
(ii) reducing duplication of material presented in various disciplines when taught separately.
(iii) teaching science with free crossing the boundaries laid by traditional subjects.
(iv) attracting more children to opt science at higher level.

The teachers with slight insight can prepare their own resource material which can tailor fit to their own requirements.

Science Teaching In Higher Secondary Schools

Science is taught as an optional subject in higher secondary schools of the state. It is categorised as Physics, Chemistry, Biology/ Mathematics. The course is of three years duration. For students, not offering science, a general science course is given. The number of higher secondary schools, both in private and government control is 10,000 approximately. The examination at terminal stage is conducted by the Board of Secondary Education, Madhya Pradesh. The syllabus is prepared by a committee of this board and the approval for the same is given by the government. Science textbooks are prescribed by this board. Private agencies publish them. Science laboratories are assisted by the grant and aid from the department. Two types of science teachers manage teaching science in these schools:

(i) Graduates in science with education degree.
(ii) Post Graduates in science with or without education degree.

The status of science teaching in these schools is rather hopeless. There are many factors, which influence it:

(i) Science courses at middle school level are more modern than that of at higher secondary level.
(ii) Science laboratories are ill equipped, outdated and are of historical importance only.
(iii) Science teachers lack confidence in handling science equipments. For want

of resources, their content knowledge is not upto date.

(iv) Science teachers use ineffective mode of presentation.

(v) Examinations are based on rote memory only.

(vi) The use of educational technology is minimal.

Besides, to keep the state in phase with National aspiration, the 10+2 pattern has been introduced in state from this year. This will make the condition of science teaching more miserable if immediate steps are not taken at this juncture.

Aims and Objectives of Teaching Science at Higher Secondary Level

The main objectives of teaching science at this stage are:

(i) Strengthening, previously learned science concepts, so that new concepts may emerge for higher learning.

(ii) enabling students to choose their future career—engineering, medicine etc.

(iii) enabling children to relate science as an important tool to serve mankind.

(iv) acquainting them with the productive role of science.

Learning and Its Application in Science Education

Recent researches in the field of learning and their applications in teaching of science will help the teacher in evolving the right approach and methodology in teaching learning process. The Psychologists view:

(i) Thinking process and the role of languages is vital in learning.

J. Bruner

(ii) What a person can learn depends on what he already knows.

R. Gagne

(iii) Learning can be effective when new ideas can be incorporated into the structure of thought which is already established by previous learning.

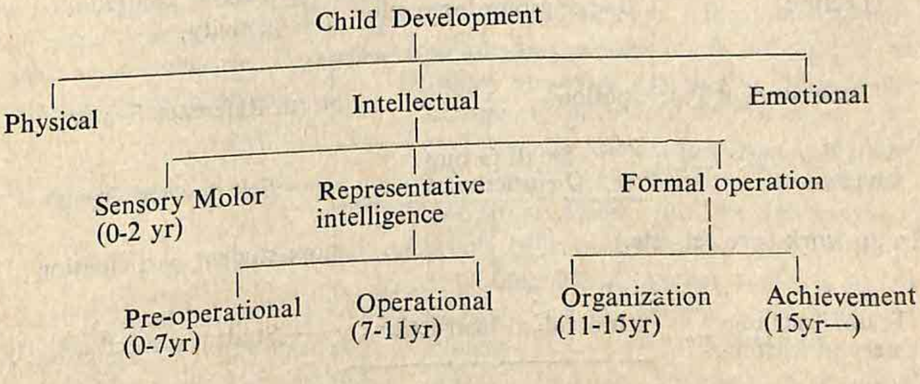
Ausubel

(iv) Learning depends on child's own action.

J. Piaget

Although science teaching is swinging between Ausubel view Piagetion view like the dual nature of light, but the piagetion veiw is accepted to be more useful as it is comprehensive and well supported by the experimental evidences.

The flow-chart of Piagetion stages of child development are as under:



According to Piaget in real life emotions and intellect are inseparable, as emotions drive force for behaviour and the intellect then structure them for making various types of emotional responses.

Motivation, both intrinsic and extrinsic, the individual differences, the level and pattern of development of each pupil may help the teacher in designing learning experiences suitable to the pace of learning of that particular pupil.

Piagetion theories are under studies in many a science teaching projects all over the world i.e. Australian Science Education Project, U.K.5-13 science etc.

It is observed in British school that most of the existing science curriculum mis-match to the abilities of average child who are learning compulsory science.

Lastly the code of effective science learning is yet to be cracked by both the Scientists and the Psychologists, the day it is done the most of the mysteries will be unravelled.

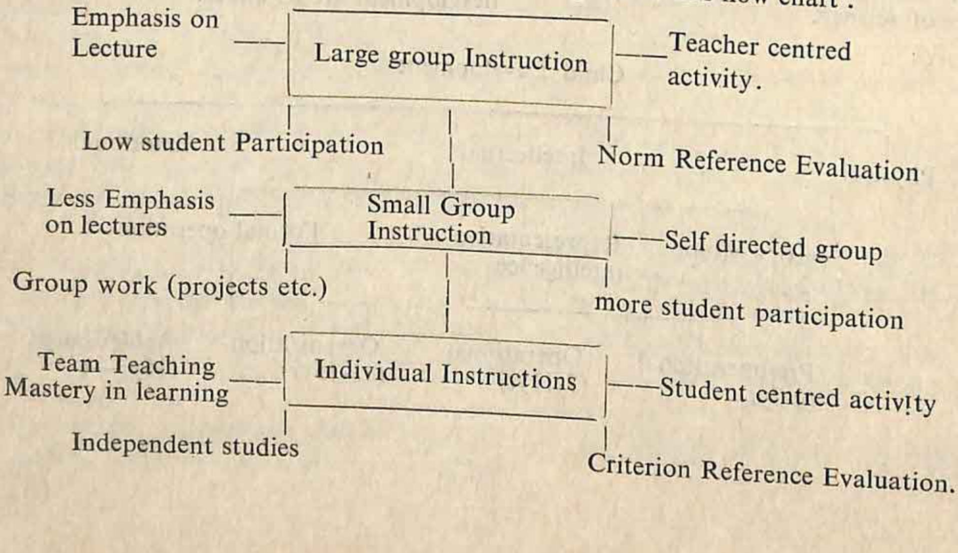
Teacher and Teaching Strategies

Every now and then new science content after being evolved is introduced into the schools. This has made the task of science teacher difficult. As enrichment is not given in this continuously changing science and its methodology, the teaching has become in effective in schools. P. Klapper view that :

> The large classes, the inexperienced teachers the long teaching day, the heavy teaching assignment—these are not the primary causes of ineffective teaching in our schools, rather they are the secondary cause which have intensified it. The fact remains that science teacher's cannot maintain themselves for long, without access to the tremendous and expanding world literature in his field. Nor can an advance training programme be successful without such access. The provision of adequte library facilities, reference materials, science magzines and journals etc. need stress.

Like-wise expensive equipments are found lying idle in science laboratories for want of know how to use them. Schools also lack the facility of repairing, broken down instruments for want of technical skill and spare parts. As no one can learn from non-operable instruments, the training in repairing and maintenance of instruments have become essential.

Research in the area of science teaching strategies have brought many techniques in light. Science teacher can select the desired ones, according to the size of the class, the abilities of the children the nature of content and facilities available to him. Some of the strategies are given in this flow chart :


Emphasis on Lecture
Large group Instruction
Teacher centred activity.
Low student Participation
Norm Reference Evaluation
Less Emphasis on lectures
Small Group Instruction
Self directed group
Group work (projects etc.)
more student participation
Team Teaching
Mastery in learning
Individual Instructions
Student centred activity
Independent studies
Criterion Reference Evaluation.

For primary and middle level science teaching, more stress on Individual and Small group instructions should be laid.

Instructional Aids and Mathematics

To arouse interest and to broaden concepts, textbooks, encyclopaedias, teacher-guides, programmed instructional material and audio-visual aids must be supplied to the schools. Skill of improvisation, using environmental situations and locally available material and selecting appropriate aids should be developed in every science teacher.

Evaluation

Techniques of evaluating formative and summative learning should be learned by the science teachers. The former will help in diagnostic testing (criterion reference evaluation i.e. mastery of the content), while the latter will help in discriminating the children according to their abilities (norm reference evaluation). The ability to construct various types of objective based test items, the skill to choose appropriate test items from question bank should be inculcated in science teachers. The teaching and testing must go together to strengthen the teaching learning process effectively.

Steps to Improve the Situation

Short Range

In the light of suggested NCERT syllabus, the additions and omissions in the state curriculum are done from this year. The textbooks are in the process of revision. The teachers-guides based on use of environment and locally avilable material have been prepared. After field testing them, they will be provided to each school. The pre-service B.Ed. course is likely to be recasted, wherein science content and methodology will be taught, to all. At pre-service level, the need is to provide extensive enrichment of science content, alongwith the techniques to present it effectively. The skill of using educational technology must also be practiced by them. The wholesome effort should be to mould the outlook of teacher, so that he acts as teacher all through his career. B. Ed. (Science) course run by State Institute of Science Education, Jabalpur can act as a model to reshape B.Ed. courses of other training colleges, in our state.

At in-service level, the need is to involve systematically the practicising teachers in staff development programmes. Short term courses on enrichment of science content, on fusing content with methodology, on repair and maintenance of instrument etc., should be conducted in training colleges. Science counsellors should be employed to give guidance in science teaching. Installation of centres and science forums will prove an asset to science teachers.

AISEP

All India Science Education Programme is undertaking a multifacet programme of providing in-service training to higher secondary lecturers of the school. In this major part of 10 days training time is spent on "doing science" and "making teachers to do science". The content is fused with methodology. Appropriate educational technology alongwith the new strategies of science teaching are used in running the programme. On the basis of available feed back from AISEP trainees the task of preparing instructional material will be undertaken in future.

Long Range

National Educational policy demands--to enable an individual to rise to his potentialities and then to develop a way to lead a better life. To achieve it, interaction with environment at primary stage and mastery in skills to live in at secondary stage need to be highlighted. Adults and Adolscents should be given science based education for work they are doing or intending to do. A wide range of vocational spectrum need to be coverd at this stage.

Teaching will be organised in two steps (For in-service science teacher):

(1) (a) Condensed B.Sc. course (for higher secondary pass science teacher) of two years duration--to enable primary teachers to act as middle school teachers.

(b) Condensed M.Sc. (for B.Sc. B.Ed. science teachers) of one year duration—to enable them to act as secondary school lecturers.

(2) Four week reorientation course (after every three years) should be given to science teachers to acquaint them with the new developments in their field of work.

Academically sound, experienced science teachers be given the job to uptodate informations in science in schools, science cells/ centres.

In each block a science cell should be established. This should have a link with District, Division, and State Science cells/centres. These centres should act as an apex bodies, wherein provision for performing science experiments need be made. The task of planning curriculum, field testing it and then rivising curriculum should be done by them. The centres should also undertake the managing task of arranging in-service short term courses, seeking expertise from local polytechnics and training colleges. The staff for these centres must be drawn from the enthusiastic science teachers working in the field. The coordination between various agencies like Text Book Corporation, Board of Secondary Education and the SCERT should necessarily be sought.

State Institute Education, must publish a monthly magazine, and at time to time some brochures, to disseminate new ideas in science content and methodology. It must also undertake the task of preparing materials for bridging the gap between (10+2) science content and higher secondary science content, as it will prove a necessity for science teachers.

Funds for equiping libraries and laboratories be provided in consultation with science institute. A workshop be established for developing new patterns of science apparatuses, which may be needed in schools in due course. Use of computers in schools be encouraged and the centre for preparing software be created at SISE Jabalpur in its Audio Visual Cell.

Better late then never. We must start the chain reaction to produce the decision making man power, then and then only we can step up from the category of developing to the developed Nation.

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Learning Science Through Observing Process

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In the last century, the teaching-learning process was simple. But as the knowledge grew, the students were required to study more subjects. Gradually special areas of study found a place in the various disciplines. The responsibility of teachers, especially those teaching science and mathematics, became more comprehensive in scope. The methods of science teaching have also undergone change. In the modern science teaching, both theory and practical work on the part of students is emphasized. Theory topics include facts, principles, formulae and description of the working of apparatus. In practical work the pupils are expected to perform certain practicals in various science subjects so as to acquire necessary skills. They develop the skills of handling apparatus and are expected to apply the gained knowledge in new situations, both in and outside the class.

But instruction in science is generally not taking care of certain "cognitive requirements" of the children to the desired extent at a particular level of development. Consequently, they are not able to develop among the students the requisite abilities and interest in science. The abilities in science are known as processes. But due to lack of development of science processes the students do not grasp the essentials which form part of their cognitive structure.

Students are not provided with first hand experiences from their immediate environment. They lack practical skills. The content is taught through reception learning which also dominates the examination system.

The practical work in science is to be based on certain processes of science. These processes help the students in sequencing the knowledge in their cognitive structure. Therefore, the emphasis has to shift from the acquisition of knowledge to the process of acquiring knowledge as pointed out by Jocobson (1970). The processes are not only useful in solving scientific problems, they are also necessary in dealing with the problems of daily life. These processes start developing among the children during the early stages of development. The processes identified thus for include observing, classifying, measuring, predicting, hypothesing making, hypothesis-testing, drawing inferences, applying, computing and describing. Through practical work in science the teachers should aim at developing these processes among the students. The best way to solve a problem is through the processes of science and to solve the problem correctly is the product aspect of science learning. The observing process is emphasized because it enables the children to learn science at various stages of education.

The Process of Observing

Observation, according to Jocobson (1970), is the basic process by which information is obtained. It involves all the senses, having feeling and smelling etc. to an observation. Observation is an act whereas the observer is like a camera in which the observations are recorded and seen. Elaborating the act of observation, George Woodban and Oburn, 1965 says, "What is observed depends, not only upon what is there to be observed, but upon the observer and what has previously been observed". According to the U.S. Commission on Science Education (1967), observation means beginning with identifying objects and object properties.

The scheme of organising the scientific knowledge, according to Romy (1968), involves three aspects, namely :

(i) Observations and facts (lowest level) ;
(ii) Concepts, generalisation and principles, and ;
(iii) Conceptual schemes (highest level).

Observation has been described as a skill which can be developed through careful training. Through systematic training in observation the children can make use of their senses of seeing, hearing, feeling, smelling and testing. At the elementary stage the process approach is all the more important in environmental education where the process of observing plays a crucial role. This approach is emphasized in a manual on outdoor education of public schools of Mansfield, Ohio (USA) where the children are required to :

(i) Be alert and use their senses,
(ii) Investigate the scientific phenomena, and
(iii) Take notes and draw sketches.

Observations are of two types, qualitative and quantitative. Observations are basis to any scientific investigations. These observations, in turn, lead to the drawing of inferences which can be tested by further observations. Therefore, observation provides both, a basis for constructing an inference and for testing the existing inference. In conducting practicals in science, observation is the basic process by which information is obtained. Objects, changes in objects and the evidences of interaction between the objects can be observed. In science, observations are carried out in a systematic way. In experiments, one or more factors are altered and the effect of change can be observed. For example, change in current in a particular circuit may be responsible for causing a change in voltage. In some cases instruments are used to extend the range and sensitivity of the senses. The magnifying glass is an example of such an instrument. It permits the observation of small objects and phenomena better. It is important that children recognize that they are a part of observing. What they will see will depend, among other factors, upon their sensory activity, previous experiences and expectations. The nature of observations also depend upon the hypotheses that have been formed. These hypotheses can lead to observations that might otherwise be missed. Sometimes children patronise some hypotheses and ignore other important observations that contradict the hypotheses.

Some Illustrations of Observing Process

The author gave the following exercises in Physics to a group of secondary school students :

Ex. 1. You are given six pieces of laboratory equipment containing burettee, measuring jar, pipette, R.D. bottle, glass and beaker. All these are filled

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with water of approximate equal volume. You have to identify two sets of apparatus which can contain equal volume of water. These six sets have also units of volume marked on them.

Ex. 2. You are given four sets of three magnetic instruments namely, magnetic bar, magnetic needle, and a horse-shoe magnet. These are arranged in a certain sequence in each set. You have to find out which of these two sets are identical. The magnets are marked on them the two poles—North and South.

Ex. 3. A student has set up an electric circuit. He has also drawn its sketch in his notebook. But due to certain reasons four errors were committed by him in the second figure. Find out these faults.

In all these examples, pictoral stem of the questions were used. The purpose was to judge the observing ability of the pupils, both quantitatively and qualitatively.

Conclusions

Some conclusions derived from these experiments are as follows :

1. Students who were weak in recording observations from the measuring instruments could not give correct answers. Secondly, the students who had not formed concept of volume also could not score better.
2. The second problem was simple and was based on qualitative observation. The students had to be alerted in recording their observations of the location of poles, faces of magnets and sequence of the magnets.
3. The third problem pertained to the electric circuit. In this task the students had to detect the four faults after comparing the given diagrams. Only those students could score better who were keen observers.

In this paper an attempt has been made to throw light on the nature and components of the process of observing in teaching science with special reference to practicals in Physics. It may be added that the process of observing can be developed among the students by encouraging them to formulate as many hypotheses as they can in a given experiment. The students may also be encouraged to record as many observations as they can. Further, they may record even the very minor changes which they observe in a scientific phenomenon. They should also be given an opportunity to get themselves familiarised with their natural environment and record their observations of the scientific phenomena. The teachers may give more freedom to their students in their practical classes. They may also be guided for writing down their own observation reports.

A series of observations, for a particular experiment, may by recorded on different sets of apparatus by the students. They may also draw their own inference. Some questions are found to be emerging from the above discussions.

1. Is there any need to improve practical teaching in science for the development of observing ability ?
2. Is there any need to orient our teachers in process-based teaching ?
3. Can we develop some instructional material relevant to the practical work in different science subjects ?
4. Is there any impact of the process based teaching, thus leading to change in the mode of conducting examinations?

These questions need to be answered by the science teachers themselves and appropriate steps taken to improve the teaching-learning process.

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Integration of School Physics and Technology Education

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AS IS WELL KNOWN, in recent years there is a growing trend in "integration in science" specially at the primary and secondary school levels. The contemporary world is highly influenced by the impact of Science and Technology.

Among the natural sciences physics is one of the most fundamental and it has wide scope which includes the fields of mechanics, fluids, solids, sound, heat, waves, electricity, magnetism, light and the atom. It is a fact that no area has greater application to day-to-day life than physics. Radio, television, high-fidelity system, automobiles, supersonic jet flight, computers, lasers and space-ships are but few examples of glittering technological achievements based on physics principles. Thus physics provides theory to most technologies. The need of the hour is that technology must be made a valuable component of Science Education then alone our children can cope with the rapidly changing technological world.

Teaching of Physics

Not only in our country but in several others that the teaching of physics is essentially academically oriented. Students are asked to memorise important principles, formulae and facts in a textbook in order to reproduce those in the examination. Our school physics content and approach is formal and stereotyped ; as a result, even good students find physics difficult to follow. Many students are of the opinion that the physics they learn is not relevant to their every-day life. Even physics practicals, they complain, do not inspire them because it is conducted just to verify the known laws mechanically by following detailed cook book instructions.

Also, the present school syllabi in physics contain very little references to technology. Many textbooks have not given importance to practical applications of physics.

All these factors call for a different approach to the teaching of physics. It is suggested to introduce more applied physics in the science curriculum with a hope that students will discover more excitement and challenge of modern technology.

What is Technology ?

According to H.A. Foecke, "Technology is the reservoir of techniques, materials, devices, etc., which have demonstrated usefulness in achieving various tasks, the reservoir being built up through creative instances of design or problem-solving, a process which flows from man's desire to improve his lot, to find ever new and/ or better ways of satisfying his needs". Therefore, the technological process cannot receive meaningful contributions from the academic study of physics. Technology is a creative process involving positive and practical application of physics. The study of integrated physics should enable the students to appreciate the social and moral implications of technology. In most of the countries, Science and Technology together have changed the pattern and quality of human life at all levels.

Since our country is in the process of industrialization there arises a need for suitably qualified and skilled manpower. This can be achieved only when we revamp and revitalise science courses at all levels of education. Therefore, technology should be incorporated into the basic physics course. Technological activities should give the students a sense of purpose, enjoyment, involvement and satisfaction.

Examples of Technological Subjects and Projects

The physics of technology programme coordinated by the American Institute of Physics has produced a number of modules, each of which gives importance to a single technological device and gives a student an insight into some of the physical concepts involved and most of these are commonly found in our technological society familiar to the student.

The following are some of the available module titles with their corresponding objectives:

The guitars—wave motion and sound
The binoculars—physical geometrical optics
The camera—optics and photographic measurements
The incandescent lamp—thermodynamics, current, electricity and photometry
The power transister—temperature and heat transfer
The loudspeaker—sound production, radiation and detection
The solenoid—magnetism
The projector—geometrical optics
The pressure cooker—thermal properties of matter
The pile driver—kinematics work and energy transformations
The Geiger counter—radioactivity and nuclear physics
The laser—modern optics and quantum mechanics
The fluorescent lamp—atomic physics
The hydraulics devices—hydraulics and equilibrium
Analytical balance—measurement, errors, and mechanical equilibrium
Automobile ignition system—electricity and magnetism

The following is a list of typical technological projects:

Telescope—design and construction
Solar water heater—design and construction
Rubber (physical properties)—strength, elasticity, resilence, electrical and thermal insulating properties.
Metallurgical study—crystal structure, microscopic inspection, equilibrium diagrams, effects of controlled heat treatment.
Structure—design, construction and testing a simple structure such as a wooden framework and bridge
Electronic equipment—construction of power supply, signal generator, voltmeter, ammeter, etc.
Logic circuits—relay operated, transistor operated, logic puzzle circuit, design based on Boolean algebra.

Home burglar alarm—design and construction

Digital clock—design and construction

Hydraulic applications—flow tanks, impact of jet, wave machanism

Through meaningful discussion within the classroom or on suggestions from outside the school such as industry, the project work can be decided. Also by consulting magazines and journals such as Popular Science, Popular Mechanics, Science Teacher, Physics Teacher, Science Education, School Science Review and Physics Education, additional projects can be selected. □

Catabolin : the clue to arthritis ?

MARK F. BROWN

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Disability through rheumatoid arthritis is brought about by destruction of joints in the body. Research is implicating catabolin, an intercellular messenger discovered in Cambridge which is opening up a new approach to the study of the disease.

STRANGEWAYS RESEARCH Laboratory has worked on the problems of rheumatoid arthritis and related diseases since it was founded as the Cambridge Research Hospital in 1912. At first it took in patients, but its clinical work was transferred in 1923 to St. Bartholomew's Hospital in London and attention was then turned to the culture of cells and tissues.

This technique, now widely used as a way of investigating the physiology of cells and tissues under controlled conditions, was largely developed by Dr. T. S. P. Strangeways, the founder of the Laboratory, and Dr. (now Dame) Honor Fell, also at Strangeways. Though the very first experiments on keeping cells alive in culture were made in the 1880s by Roux, the founder of modern embryology, in Prussia, satisfactory cultures in which cells could be shown still to behave normally were not made until 1907, when Ross Harrison in the USA explanted small pieces of frog embryos into clots of frog lymph. These, kept aseptically, survived and nerve fibres grew out, proving that this culture at least showed more than delayed death.

However, all the early tissue culturists tried to make cells grow as rapidly as possible, and all organization was lost. The idea of trying to keep pieces of tissue in as close a state to normal as was possible came in 1914 from Dr. David Thompson at the Royal Society of Medicine, London, and was developed by Strangeways and Fell, with the emphasis naturally placed on connective tissues and joint materials.

Some years ago, we set up a department of tissue physiology specifically to investigate joint damage, using tissue-culture models. We have examined the cells in these cultures and measured their uptake and release of precursors and substances produced when the tissue is broken down.

Cartilage

In a typical synovial joint, the parts important for mobility are the surfaces of the articular cartilage, which are lubricated with synovial fluid. This is produced by the synovial membrane, or synovium, which lines the joint capsule and often forms small projections into the joint cavity, called villi. They are especially prominent in disease, when the synovium is inflamed.

Cartilage consists of cells known as chondrocytes, scattered throughout a matrix which they produce. The matrix is a mixture of collagen, a fibrillar protein that forms a very strange network, and a substance known as a proteoglycan aggregate, which consists of chondroitin-sulphate and keratan-sulphate side chains attached to a protein core. Between 10 and 30 of these molecules interact with a long chain of hyaluronic-acid residues. In this way a huge polymer is formed which, in cartilage, is heavily hydrated and consequently swells against the restraint of the collagen. This gives the cartilage resistance to the compressive and tensile stresses that are imposed by movement in the joint.

Interaction

In rheumatoid arthritis there is structually and biochemically demonstrable loss of proteoglycan and, later, of collagen ; while the cartilage is breaking down, it gives the appearance of having been invaded by the inflamed synovium. Because of this, it has in the past been generally thought that the synovium was causing the breakdown by secreting proteolytic enzymes, which catalyse the breakdown of proteins into simpler substances. But an equally plausible explanation would be that some change in the cartilage allows the proliferating synovium to grow into it.

The way synovium and cartilage interact is being investigated with the use of organculture techniques. Such experiments started in 1952, when Fell and Mellanby studied the effects of vitamin A on small pieces of limb bone from embryonic chicks and foetal mice. At such a stage, before they harden, the bones are pure cartilage. Marked resorption of matrix by the synovium was shown to take place and, in 1966, it was demonstrated by Fell and her colleagues that a number of other agents had a similar effect.

Similar experiments were made on adult tissues including human, rabbit and pig articular cartilage, with the same results. The next thing to do was to study the enzyme mechanisms for the degradation of both proteoglycan and collagen. Recently it was found that resorption could be induced if synovium or connective tissue was included in the cultures with the pieces of cartilage used. To investigate this phenomenon further, in 1977 Fell and Dr. Ronald Jubb of the Department of Immunology at Cambridge University cultured minced synovium from young pigs' trotters together with strips of the articular cartilage. They found that dead synovium had no effect on the appearance of the cartilage or on proteoglycan release. Living synovium in contact with cartilage caused release of proteoglycan and visible degradation of cartilage, and synovium separated from cartilage caused degradation when the cartilage was living, but not when it was dead.

So there must be two separate mechanisms of degradation : because dead cartilage is degraded, the synovium must be releasing proteolytic enzymes, and because this effeet is not shown when cartilage and synovium are separated, the enzymes must be nondiffusible or be inactivated in the culture medium. The enzymes, then, cannot be involved in the degradation of the living cartilage at a distance, and we must look for some other mechanism.

Because it is seen only in the living cartilage, the degradation must be mediated by the chondrocytes, which must be stimulated to do this by something produced by the synovium. Although this could be a non-specific change in the waste products of the synovium, the notion of a specific catabolic factor is more attractive and perhaps more plausible. After its existence was suggested by Dr. J. T. Dingle of our laboratory, it became desirable to identify it, and we have been working to do so.

Replicate Assays

So far, the only way to detect the presence of this unknown factor is by the effect it has on cartilage ; moreover, because of the difficulty in obtaining large numbers of equivalent pieces of articular cartilage, an assay based on the release of chondroitin sulphate (proportional to total proteoglycan) from bovine nasal cartilage was tried. The putauve factor had the same effect on the nasal cartilage, and this assay was adopted. The nasal septum that separates the nostrils of cattle is a large block of reasonably homogeneous cartilage which can be cut into several hundred discs for replicate assays, which are necessary because of the large amount of individual variation in biological assays.

Slices about a millimetre thick are cut aseptically from the nasal cartilage block. The slices are kept sterile and washed with sterile medium, and discs cut out with a sterile punch. They are cultured for eight days with one millilitre of medium, changed after four days. In a recent modification to this procedure, two-millimetre discs are used with 0·35 ml of medium for six days continuously. This provides a higher ratio of tissue to medium and is somewhat more sensitive. It also allows more assays to be done, for less medium is used, and therefore is more accurate. Finally, discs and medium are digested separately with papain, an enzyme, and chondroitin sulphate is then assayed spectroscopically by measuring the absorbance shift of dimethylmethylene blue dye added to the samples.

Using this assay, Dingle and others found that the synovial medium caused 80 per cent or so release of proteoglycan. They found that the substance they were seeking could be precipitated (along with a large proportion of the protein in the medium) with ammonium sulphate, and that it could be retained by a dialysis membrane. It was inactivated by heat and by digestion with certain enzymes, namely chymotrypsin and pancreatic elastase.

It appeared, therefore, that there was a specific factor, a protein apparently, and they named it catabolin. Further investigation using such techniques as gel filtration, ion-exchange chromatography and isoelectric focusing confirmed it to be an acidic protein with a molecular weight of between 18,000 and 20,000.

Purification of catabolin is being tackled at the moment, but is proving difficult : it appears that the substance works at concentrations of less than 10^{-10} molar, so vast amounts of raw material will be needed for a preparation anywhere approaching purity.

Cavity Organ Cultures

Meanwhile, an investigation has been undertaken by Dr. Dingle and Timothy Dingle, also at Strangeways, into the site where cartilage is degraded, to find out whether the chondrocyte-mediated degradation is important in practice. Bovine nasal cartilage blocks were made, measuring 13 × 4 × 4 mm, with a hole in each which could be closed with a stainless steel screw. In this way they obtained closed cavities bounded by living cartilage. These 'cavity organ cultures' were kept in media, some of which contained retinol or catabolin. Into the cavities were introduced radiolabelled proteoglycan aggregates, either on their own or incorporated into polyacrylamide beads to prevent diffusion. At the end of the incubation, the contents of the cavities were recovered by centrifugation and the approximate size of the aggregates was found by gel filtration. The cavity organ cultures and the culture media were digested and analysed for chondryitin sulphate, to measure degradation.

It was found that, as expected, proteoglycan release from the cavity organs was small, less than 20 per cent in dead or unstimulated cases, and was almost complete in those with catabolin in the medium. With retinol in the medium, loss was around 60 per cent.

These results were reflected in the pattern of breakdown of the aggregates placed directly in the blocks: the contents of catabolin-stimulated blocks were quickly broken down, those of retinol-stimulated ones more slowly and of dead or unstimulated ones hardly at all. However, when the contents were bound in polyacrylamide beads, breakdown was very small whether or not the cavity organs were stimulated. But the beads do not prevent soluble proteinases from acting upon the aggregates, so it is obvious that these proteinases are not involved; the breakdown of soluble proteoglycan aggregate in the stimulated cavities is caused by its diffusion to the edges of the cavity, where chondrocytes cause breakdown in a region around the edges of cells. This agrees with immunofluorescent enzyme markers which, when applied to cartilage, fluoresce in only a narrow band around the chondrocytes.

Other Tissues

Since catabolin was discovered, work has been going on here to find out whether any tissues other than synovium produce it. Quite early on it was shown that it, or something with similar properties, was produced by connective tissue and tendon; since then, activity has been found to be connected with the connective tissue covering of bone, from the aorta and from heart valves. This suggested that catabolin or 'catabolins' may control the turnover of connective tissues throughout the body. Dr. Lynn Pilsworth, working here, has shown that catabolin is produced•by cultured fibroblasts, cells with branching processes that from part of connective tissue. It happens mostly when the cells are at the proliferating stage. This may have something to do with the fact that rheumatoid, proliferating synovium produces more activity than normal.

Catabolin appears to act on more than just cartilage. Experiments carried out by Dr. Dingle and Dr. Robert Decker, a visitor to our laboratory from Dallas, USA, show that it degrades the matrices of synovium itself, of heart valves, and of aorta. It is likely that catabolin has something to do with the control of matrix turnover in many, if not all, connective tissues, so if whatever goes on can be influenced by some form of therapy there are important clinical implications.

Healing of Wounds

It was shown quite early on that very low doses of corticosteroids, steroids produced by the outer portion of the adrenal glands, near the kidneys, could completely suppress production in culture. This is presumably one way in which steroids work in treating rheumatoid arthritis. It implies that although very high doses of cortisol are usually given, it might be just as effective to administer low doses together with a non-steroidal anti-inflammatory drug such as aspirin to control the inflammation. Such a course might do a great deal to reduce the side effects of large amounts of steroids, including swelling, obesity and poor healing of wounds.

Catabolin could well have a lot to do with healing of wounds. If it is normally important for connective tissue turnover and remodelling, it must presumably be necessary for healing; when steroids prevent it being produced, healing is inhibited. It may, too, have something to do with obesity, for it may be involved in adipose tissue turnover and its absence may cause fat to be stored. Research into the connection between wound healing in general and catabolin is being started here by Dr. Erjia Qi.

However, it is the connection with rheumatoid arthritis that is still receiving the most attention. One important line of research we have recently begun is an attempt to find out whether drugs have similar effects in the body to those in tissue culture : that catabolin is produced in large amounts in culture is probably because of the stress of that technique. It is likely that in the body, catabolin is produced in significant amounts in pathological conditions only, that is, in arthritic diseases. So a project is under way to measure production in samples of synovium removed from patients by the biopsy technique known as arthroscopy. The catabolic activity will be correlated with the state of the joint (some are normal and some in various stages of rheumatoid change) and with the drug treatment.

Our first aim is, of course, to understand joint damage in disease, particularly in rheumatoid arthritis. That seems likely to be achieved. The long term aim is to control the damage. To suppress the production of catabolin completely is likely to be undesirable ; perhaps, if specific receptors for catabolin are found on chondrocytes, we ought to search for something to block them.

At all events, the discovery of catabolin has opened up a new and potentially fruitful approach to the study of the arthritic diseases. It should stimulate a lot more work in this field.

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On the Conceptually difficult matter in Chemistry

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Some basic concepts which are otherwise confusing are treated in easy to understand formalisms. Concepts treated are mole, pH and electrode potential. Some of the misconceptions among the students are also treated.

IT IS AN irony that many science degree holders seek non-science jobs in the country. One of the reasons for this is a lesser number of openings available. But, our science curriculum and mode of examinations are also to be blamed. To some extent, the type of teaching and the type of textbooks available in the market are also responsible. Prototype teaching has resulted into students acquiring only the factual knowledge (even that is doubtful) without any concern for real understanding of the subject matter. Science courses could be fruitful and popular if attention is focussed on teaching properly the basic ideas and principles. It would be necessary to start right from the elementary chemistry courses where the subject matter has some conceptually difficult and confusing topics which require a careful teaching taking into consideration the students' future progress. It is the purpose of this article to present some of the basic ideas in easily understandable formalism with the appropriate teaching aids. Some concepts are also discussed which are often misunderstood by the students. The concepts are selected from chemistry curriculum only though such an approach should be applicable to other branches of physical science as well.

The Mole

The mole concept is often misunderstood and confused by the students and is neglected by the teachers and the textbooks as well. The understending of this concept is essential, since it gives a coherent picture to the teaching of elementary chemical theory which is very crucial to the later progress of the student. While teaching about the mole, it should be emphasized that the MOLE is the SI unit for measuring the amount of substance. Mole is a number. It can be compared with such collective terms as a dozen, 144 number in one gross; similarly there are 6.02×10^{23} number of chemical entities in one mole. This is a very large number, since mole, gives a microscopic picture of the microscopic entities like atoms, molecules, ions, electrons, etc. Detailed discussion of this concept is beyond the scope of this article and can be found elsewhere. However, a simple visual aid is worth mentioning here. Take one dozen glass balls of different sizes (say 1/2″, 1″ and 1½″) in each of the three different sized beakers to fill them and also fill exactly one mole of each, say, 12 of carbon, 82 g of lead and 342 g of sucrose respectively in these beakers. Small balls filled a small beaker weighing the least of the three; similarly a mole of carbon atoms will weigh the least because of the smallest size of the carbon atoms among three substances.

pH

Many students find this concept a little confusing. They often say: "If pH is a measure of acidity, then how is it that pH goes up when the acidity goes down". Not only is the relationship between pH and acidity an inverse one, but also it is a logarithmic one. A decrease of a single pH unit corresponds to a ten fold increase in the acidity of the solution. Mathematically, pH (p is negative of log)$=-\log(H^+)$ where (H^+) is molar concentration, more precisely $pH=-\log(H^+)$ where (H^+) is hydrogen ion activity (effective H^+ ion concentration). It should be emphasized that idea of pH scale is for practical purpose and is not arbitrary. The pH scale follows from natural equilibrium that exists between H^+ and OH^- ions in water solution. In a sample of pure water at 25°C, the concentration of H^+ ions is $1 \times 10^{-7}M$ and OH^- also have the same concentration. And, $Kw=(H^+)\times(OH^-)=10^{-14}$. This means that in any water solution, no matter how acidic or basic the solution might be, at 25°C, it must be true that $(H^+) \times (OH^-) = 10^{-14}$. Taking the negative logrithm of each term, we have, $pH+pOH=14$. This should explain the O – 14 range of pH scale in which, 7 represents neutrality. It may be mentioned that this scale is for dilute solutions only; pH greater than 14 is possible for strong bases and negative for strong acids and is valid only for solutions at around 25°C. At O°C, $pH + pOH = 15$ and at 60°C $pH + pOH = 13$. A simple visual aid as shown in Fig. 1 can be very effective.

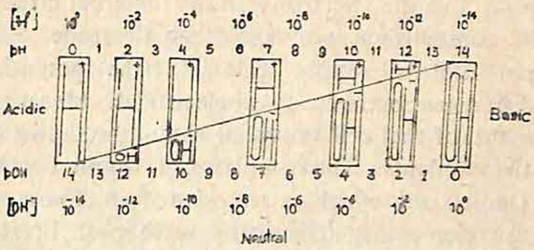

Fig. 1. A visual aid for pH scale. It is clear that at all pH levels $(H^+)\times(OH^-)=10^{-14})$ and $pH+pOH = 14$.

The Cell Potential

This is one of the highly confusing concepts due to the lack of understanding of physical nature of electrode potential and the use of left/right electrode in the sell diagram formalism. Here is an approach which does not require this formalism and is easy to understand. First of all the students may be given the ideas of electronic and ionic conductivities and the idea of electrode potential can be introduced by defining the potential itself. The electrode potential depends on any excess electronic charge that exists on the electrode and can be represented by the equilibrium.

$$M^{n+}_{aq} + ne^- = M$$

where M^{n+}_{aq} are metal ions in solution and ne^- are free electrons on the surface of the metal electrode. It will be necessary to emphasize this equilibrium.

For example, increasing the M^{n+}_{aq} concentration would decrease the surface electronic charge concentration in order to restore the equilibrium. This decrease in surface electronic charge would make the electrode potential less negative i. e. electrode potential would increase. On the other hand, more is the electronic charge, greater is the negative potential and therefore would be having higher tendency to push out the electrons in the external circuit in competition with the other electrode. Cell potential is simply equal to the potential difference between two electrodes. Measurement of the cell potential should be shown to the students. The simplest cell would be the Daniell cell which is represented in almost all the elementary chemistry textbooks. In this cell, Zn electrode is said to be negative w. r. t. copper electrode. Therefore electrons flow from Zn to Cu-electrode in the externalcircuit. The competition of electronic charge in the two half-reactions is represented as:

$$Zn^{2+}_{aq} + 2e- = Zn, \quad E^{o}_{zn} = -0.76V \text{ vs SHE}$$

$$Cu^{2+}_{aq} + 2e = Cu, \quad E^{o}_{cu} = 0.34V \text{ vs SHE}$$

From this, it is clear that Zn electrode is more negative i.e. has excess electronic charge w.r.t. Cu-electrode. So, it gives out electrons and it is the electrode where oxidation occurs. For the spontaneous cell reaction,

$$Zn + Cu^{2+}_{aq} = Cu + Zn^{2+}_{aq}$$

Cell potential measured experimentally would help the student indentify the spontaneous cell reactions. This approach can be used to predict the spontaneous direction of a reaction based on the table of E^{O}– values and, further, the relation $G^{O} = -n \; FE^{O}$ would help in deciding about the sign of E^{O}. This formalism makes the Nernst equation more meaningful also which can be written as $E = a + b \ln M^{n+}_{aq}$ where a and b can be identified by E^{O} and $\frac{RT}{nF}$ respectively.

Now I would like to point out briefly some of the concepts/principles which are badly represented in the textbooks and often misunderstood by the students. For example, Pauli exclusion principle is presented as "only two electrons are allowed in the *same* orbital, provided they have spins in opposite directions". This was Pauli's original principle minus the part of spins, since at that time electron spin and magnetic moment associated with it had not been discovered. After the discovery, it was shown that electrons must spin in opposite directions and move in two separate (though very similar) orbits as shown in Fig. 2.

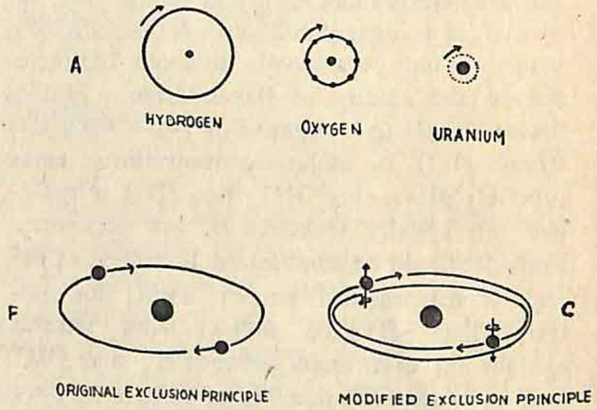

Fig. 2. Pauli's Exclusion Principle—Old and new A,atoms would differ in size according to laws of classical physics, since all of an atom's electrons would occupy 1st orbit (lowest energy state). Secondly, this orbit would be smaller in heavier atoms because of increased electrical attraction between nucleus and electrons. Actually all three atoms are approximately equal in size.

B. Original exclusion principle permitted two electrons to move around a nucleus in same orbit. Electron's spin and magnetic moment had not been discovered.

C. Modified exclusion principle necessitated by the discovery of electron's magnetic moment, states that two electrons must spin in opposite directions and move in the separate orbits.

The need of having Pauli's Exclusion principle should also be taught to the students. Another misunderstood idea is the stability of electron pair. Many student are found to say that electron pair is very stable due to the attraction between the tiny magnets (spinning electrons is *regarded* as a tiny magnet). It should be emphasized that it is not the attractian, but electronic repulsion which is much greater. The example of ionization energy is worth mentioning here. First ionization energies for Be and B are 900 and 800 kJ/mole respectively. The anomalous decrease is not due to the stability of electron pair which is mostly thought by the students to be present in Be, but is due to placement of the extra electron in 2p orbitatal of B which is less shielded from nucleus. These were the examples of some of the generally misunderstood concepts. If the students understand the basic concepts truly and would be able to apply the know-how to solve the problems, he would be more *interested* in science. This will be possible if emphasis is placed on the basic concepts/principles in teaching of Physical Sciences as has already been done in *the western* countries.

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Proper teaching is meant by teaching where more emphasis is given on learning and is supplemented by teaching aids (including charts, models, experiments etc.), self learning instructional materials for weaker students, short answer type questionnaire after teaching every topic etc.

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Science News

Planet beyond solar system observed

ASTRONOMERS in Arizona have discovered what is apparently a giant ball of hot gas orbiting a distant star, making it perhaps the first planet ever observed beyond our solar system, the National Science Foundation, USA, announced. The U.S. Government research agency said yesterday that a University of Arizona team led by Dr. Donald McCarthy Jr had used a new technique to detect heat radiation from the apparent planet around the star 'Van Biesbroek B' which is 200 light years from earth.

They had calculated that the object must be some 30 to 80 times more massive than Jupiter, the largest of nine planets in our solar system. The estimated temperature on the outermost layer of the gases was about 1,100 degrees Centigrade. They used a four metre telescope at Kitt Peak National Observatory and 2.3 metre telescope at the University of Arizona. The team included Frank Low of the University of Arizona and Ronald Probst of the National Optical Astronomy Observatories. The light from the mysterious mass, which orbits the milky way star Van Biesbroek B in the constellation ophiuchus, is many thousands of times weaker than that of the faintest star visible to the naked eye.

/ "The body identified as planet is too dim and too cool to be a star" McCarthy said. Further studies would be needed to determine characteristics of the object such as the timing of its orbit, its mass and chemical composition. The existence of planets as large as this has been theorized by astronomers who coined the term Brown Dwarf to designate them.

The name Brown Dwarf indicates that these objects are much coolar than Red Dwarfs, which are the coolest stars known.

Sun's bulge affects mercury

THE DISCREPANCY in Mercury's orbit could be due to the effect of a slight bulge in the Sun, acccording to the renowed astrophysicist, Professor J. V. Narlikar. Studies conducted by him along with Dr. N.C. Rana, at the Tata Institute of Fundamental Research, Bombay had given them the clue, he said while delivering a lecture on the "motion of planet Mercury and general relativity" at the Osmaniabad University.

He said, however, factors like the impact of the motion of other planets on Mercury have to be confirmed before the theory can be established. After every circle, Peri Helion-Closest point that Mercury reaches in its orbit round the Sun, changes slightly. While the other planets maintain their orbits.

The discrepancy in Mercury's orbit had been measured as 45 are seconds per hundred years while Professor Narlikar's team had identified a further discrepancy of two are seconds, stirring a new controversy about the planet's motion. This puzzle about Mercury's "naughty" orbit arose way back in the 1960's and till covincing answers.

Stars gain weight and explode

A STAR in the universe explodes if it does not follow the modern fashion of keeping slim. When stars become too massive the imbalance of their nuclear energy reduces them to debris, according to the eminent scientist, Professor Jayant Vishnu Narlikar.

A star, which exploded on July 5, 1054 A.D. as per the Chinese and Japanese records, was reduced to a tiny neutron star, he said delivering the fourth lecture of the frontier lecture series at the Indian Institute of Science yesterday.

Prof. Narlikar recalled that the neutron star was detected as Pulsar in 1968. It has a density several billion times higher than that of water. He said the contribution of astronomy to the understanding of the physical world was valuable since it has opened new vistas to other branches of science. The inputs from astronomy supplemented the work being done in physics laboratories, he said and added that the interface between cosmology and particle physics was an example.

Cheaper vaccine for rabies

RESEARCHERS have developed an experimental rabies vaccine that may prove cheaper to produce than the current version, a potential boon to the Third World where the disease kills thousands of people every year. The new vaccine should be cheaper to make and effective in a very dilute form, said one of its developer, Mr. Hilary Koprowski of the Wister Institute in Philadelphia, Pensylvania. Lowered cost would be an enormous advantage for vaccinating people and cattle.

Mr. Koprowski, his Wister colleague, Tadeus Wiktor and seven scientists in Starasbourg, France, reported production of the vaccine by genteic engineering in a recent issue of Nature, a British scientific journal.

The current vaccine costs $ 35 to $ 50 per dose, and it takes three doses to immunize a person before an animal bite or five doses after a bite.

The vaccine can be effective after a bite because the rabies virus can wait for weeks at the bite site before invading the body.

The vaccine is injected into the shoulder after a bite, having replaced the painful series of shots in the midsection several years ago.

The current vaccine is essentially a concentrated dose of dead rabis virus. The virus are cultured in human cells in a laboratory, isolated and inactivated. Pre-bite vaccines are generally given to people who handle animals, like verterinarians and some laboratory workers.

Mr. Winkler, an expert at the U.S. Centre for Disease Control in Georgia, said 10,000 to 20,000 people die of rabies every year in India, which accounts for most of the world's cases. Worldwide estimates of rabies vary widely, but Mr. Winkler put the figure at about 25,000 cases a year.

The new vaccine would probably takes years to reach commercial producation, Mr. Winkler said, Mr. Koprowski said he did not know how soon it could clear regulatory hurdles, or how much cheaper it would be in commercial production.

Besides avoiding costly procedures involved in producing the current vaccine, Mr. Koprowski said the new vaccine could be diluted before administration because, as a live virus, it would duplicate and build up within the human or animal body. By masquerading as a rabies virus. It would put the immunological system "on alert" before any real rabies virus appeared.

Newton law of viscosity questioned

A PHYSICIST has claimed to have found proof that Newton's law of viscosity, the earliest law in the study of flow of liquids derived three centuries ago, is incorrect. The head of the Physics Department of the Bangalore Institute of Teachnology, Dr. S.P. Basavaraju, made the claim in a paper submitted to the 29th congress of the Indian Society for Theoretical and Applied Mechanics held in Suratkal in Karnataka recently.

Dr. Basavaraju said the experiments carried out in the Physics Laboratory of the institute provided evidence to conclude that Newton's law was incorrect. With this Prof. Possiseuille's equation for rate of flow of viscous liquid in capillary tubes and stokes equation for the viscous force experienced by solid sphere falling under gravity in a viscous media, both based on Newton's law also come under question.

Dr. Basavaraju has claimed that critical theoretical analysis had detected the flaws in the law and also the equations derived by Possiseuille. The corrected law of viscous flow was worked out with the help of theoretical arrangements he said.

The theory derived for the rate of flow of liquid through the capillary tube at B.I.T. change intriggers a change in the Stokes Law too. For reaching consequence of this chain of changes is to invite the experimental physicists to recalibrate the charge and mass of the electron, Dr. Basavaraju claimed.

Herbs to purify well water

A SIMPLE recipe of herbs based on *Varahamihira's Brihatsamhita* could purify well water of all kinds of pollution, according to Dr. Wazir Hassan Abedi of the National Institute of Science, Technology and Development Studies (Nistads), Lucknow.

A mixture of the commonly found herbs anjana, musta, ushira, powder of raj oshatika amora combined with ataka nuts could be used to purify impure water, Dr. Abedi said at international seminar of "Geobotany and Varahamihira's Brihatsamhita" at the Sri Venkateswara University's Geology Department at Tirupati.

Dr. Abedi said this mixture was mentioned in the Persian translation of Brihatsamhita titled 'Itable-Barahi-Sanghita', translated by Abd-al-Aziz Shams Baha Nuri at the instance of Emperor Feroze Tughlaq.

He said the Central Drug Research Institute at Lucknow was carrying out a scientific study to find its usefulness as an alternative purifying material to chlorine in collaboration with the Nistads.

An alternative to kidney machine

AN AYURVEDIC procedure, known to be existing for more than 3,000 years, has been found to be a viable alternative to the kidney machine in the treatment of dialysis patients and it costs almost nothing.

Dr. Jan Erick Sigdell of Switzerland, who compared this ancient method of Kriya Yoga with a modern alternative developed by Dr Tse-Kong Young of the National Defence Medical Centre, Taipei, observes that basically the two methods are the same.

Dr. Sigdell has reported his findings in the "Ancient Science of Life" journal. In Dr. Young's method, dialysis is done by creating "water diarrhoea", after the intake of saline solution in sufficient quantities with some additives. This causes filtration of all waste substances from the blood. Moreover, the practice needs no special equipment, but some patience.

In the yoga method, also called Sankha Praksalana or Varisara Dhauti, a little salt is added to a clear bucket of lukewarm water just enough to make the water salty. The patient is made to drink two glasses of the water as quickly as possible. Then the patient performs five asanas—two variations of *Tadasana*, *Kati Cakrasana*, *Tiryak Bhujamasana* and *Udara Karsana asana*—eight times each the patient excertes and then repeats the drinkings and the asanas, until after 15-30 glasses of clean water is expelled through the rectum.

Then after resting for about an hour, he is given some rice with ghee to eat.

Dr. Sigdell says he himself had performed this procedure effectively. He claims the Yoga method is effective not only in cleansing the body and therefore generally intestines but also the blood.

Pluto eclipse observed by student

An astronomy student has made the first recorded observation of the eclipse of the planet Pluto by its Moon, Charon, proving the existence of the satellite, University of Texas officials say. The brief sighting was made by Mr. Richard Binzel, a graduate student, at the university's McDonald observatory in West Texas.

Scientists have said since 1978 that Pluto's Moon, Charon, has existed but they had no visual evidence. Mr. Binzel said he had been looking for eclipses since 1982. Pluto is very far away and the orbits of Pluto and the satellite are relatively close, so even through the largest ground-based telescopes, it is extremely difficult to detect the satellite.

Artificial heart different in appearance

The Jarvik-7 artificial heart is the same size as an adult human heart, but is dramatically different in appearance and operation.

It replaces the two pumping chamber or ventricles of the human heart with a pair of cream-coloured, funnel-shaped plastic pumps, each connected by a clear plastic tube to a compressed-air driver outside the body.

The Jarvik-7 is designed to beat about 40 million times per year during its lifetime of three to five years, said Dr. Robert Jarvik, its inventor.

It weighs two-thirds of a pound and costs $15,000. The 323-pound external driver, required to operate the heart, is the size of a small refrigerator and costs $ 40,000. A portable 11-pound driver the size of a camera bag is available in experimental models only and its price has not yet been determined.

The heart is made of layers of polyurethane plastic, applied by hand to a steel mould and baked after the application of each layer.

When the artificial heart is in place, its two funnel-shaped pumps are cradled together between the lungs the stems of the funnels together and their mouths pointing down and away from one another.

They are initially held together by a nylon fastener. After about a week however the body deposits scare tissue around the heart, holding it in place.

Each chamber has one in-flow valve and one out-flow valve. Each of the four valves is sculpted from a single piece of titanium to avoid potential wear welding joints such as those in the heart implanted in Barney Clark who lived 112 days with the world's first artificial heart implant. One valve in Clark's broke 13 days after he received it and had to be replaced in emergency surgery.

The right funnel receives blood from the veins after its oxygen has been spent and pumps it to the lungs. Where it is enriched with oxygen. The left side receives this oxygenated blood and pumps it into the arteries and throughout the body.

The heart was designed in 1976 and 1977 by Dr. Jarvik, President and Chief executive officer of Symbion Inc of Salt Lake City a private firm established by Dr. Jarvik to make and sell the artificial heart.

Balloon pump for babies' hearts

A TINY balloon pump has been devised to assist babies' hearts while they heal after open heart surgery, according to a doctor at a children's hospital.

The pump is inserted into the main artery next to an infant's heart to help it pump, said Dr. Jeffrey Dunn, Chief of the Cardiothoracic section of the Paediatric Heart Institute at St. Christopher's Hospital.

Similar intra-aortic balloon pumps have helped adults recover from open-heart surgery but doctors until now have never had devices small enough or fast enough for babies.

Dr. Dunn and other doctors at St. Christopher's have inserted that doctors in Utap have successfully used the device on one infant and four older children.

The balloon works in time with the heart to open and close off the aorta. When the ventricle pumps, the balloon is deflated, allowing blood to pass by into the rest of the body.

When the ventricle is at rest, a console outside the body pumps gas through a catheter and the balloon inflates, closing off the aorta so blood cannot run back into the heart. Such devices have been used in adults since 1971, said Dr. Dunn. But in adults, they are inflated with 40 cubic centimetres of gas.

An intra-aortic balloon pump for an infant would need only 21-22 cubic centimetres of gas but it would have to work much faster.

A healthy newborn's heart starts beating at about 130 beats per minute, and a sick infants heart can go as fast as 200 beats per minute.

A dinosaur egg found

SOVIET SCIENTISTS, working in the Fergana mountains of Central Asia, have found thousands of dinosaur egg framents and one whole egg in what could have been a prehistoric breeding ground for the giant reptiles.

Some of the eggs are believed to have been laid 105 million years ago and represent the first such find on Soviet territory. "What we have found is probably a unique breeding ground of prehistoric giants who had lived and multiplied here for millions of years", an archaelogist, Mr. Lev Nesov, said of the find in south-eastern Uzbekistan.

The Bain-Dzak region in the Gobi Desert has been considered the largest area of dinosaur remains, but the new find might rival that area.

Halley's comet may hold clues to creation

International plans to intercept Halley's comet with six spacecraft promise to unlock some mystery that may reveal vital new clues about the formation of the solar system.

Dr. John Davies, from Birmingham space research department' told a briefing on the Halley project recently that, though the theories uf the origin of comets were still controversial, it is widely believed that they are material left over from when the solar system was formed. "If this is so, then they have been kept in deep freeze far beyond the sun for about four and half thousand million years".

Hally's comet expert, Dr. David Hughes when asked what practical spin-off would result from the rendezvous with the comet when it reappears in 1986, told the Landon conference. "Hopefully we will be halfway to answering the question of where do we come from and where does the thing we are standing on come from."

Professor Jack Meadows, chairman, of the committee co-ordinating the U.K. effort to study Halley's comet, said co-ordinated effort from both Earth and space should produce major lean forward in our understanding of comets. He said the key word was co-ordination because it was clear that the best return on the research project were likely to came from near-simultaneous observations spread over all the available electromagnetic spectrum.

Two Russian spacecraft have already been launched and are on their way to meet Halley while the first sightings of the comet's return have already been made from Earth. Japan has also lanched a spacecraft that is to be a pathfinder to the comet for a probe that will be lanched in August.

Europe's craft, known as Giotto, will be launched in July or early August while a United States spacecraft will encounter another comet in September before joining the Halley study.

Halley may be visible by telescope from the ground from August onwards. but the comet will not make it closest approach to Earth untill November 27. The six spacecraft will aprpoach the comet from March 1986.

Giotto will pass closest at a range of some 500 kilometres from the nucleus and is likely to be distroyed in the process. The conference was told that a space particle the size of a pea could destroy the 35 million craft as the two would be hortlino towards each other at a closing speed of 68 kilomitres a second.

The lemon-shaped comet, discribed as like a "dirty snowball", will best be seen in the southern hemisphere early in 1986. By then it will be low on the horizon in the northern hemisphere and fairly faint.

Halley, unlike most comets, reappears on average every 76 years. Most make only one flypast of the sun before returning to deep space never to be seen again. Halley, however, is trapped into an orbit within the inner solar system and returns repeatedly. When the core of a comet approaches the sun it is warmed and gas and dust are released to from a giant cloud many thousands of kilometres in diameter around it. This creates the distinctive comet's tail.

The core of Halley's comet was originally some 20 kilometres across, but each time it goes round the sun it loeses a two-metre-thick layer from it surface. As a result, the core's diameter is now halved to 10 km. After another 2,500 times round the sun the comet will disappear.

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Book Review

BBC Starter Pack—Micro B

DEVELOPED BY KEN BODLEY *et al.*
Collins Software, UK, 1984,
(i) Booklet : Pages 60 (ii) Cassettes : 2
Price : £ 19.95

DEVELOPED by a group of people in the Birmingham Educational Computing Center, this starter pack consists of two cassettes and a booklet amplifying the content of the cassettes.

To the teacher who has undergone a training programme on the BBC Micro, much of what this pack has to offer would appear redundant.

As a manual for drill-and-practice for students, however, the ten carefully designed programs on two cassettes and the back-up and extension material in the book would surely prove useful. Each of the ten programs is like a microteaching module that concentrates on a single aspect of BASIC and presents a series of points, demonstrations and exercises in a graphic and accessible form. Some of these programs are: setting up the BBC computer, getting started, simple computer instructions, controlling loops, making program decision, experimenting with RND, GOTO, TAB and the like.

Two minor points, however.

First, a disc instead of cassettes would be more convenient for student use. Secondly, the price of the pack appeares to be a bit too high.

□

Science Education and Ethical Values
Edited by David Gosling and Bert Musschenga, WCC Publications, Georgetown University Press, Washington

IT IS said that scientists are an isolated lot, delving in separate a realm of their own, persuing a quest generally value-free and in the process develop an attitude of omnipotence and limitless possibilities and or power. There is also a line of thinking that science has created more problems than it has solved. The invention of nuclear fission divice has no doubt opened the door to an alternative source of energy but at the same time has brought a permanent threat to distroying a vibration on a world wide scale by way of nuclear weapon. The promising future of peaceful application of nuclear technology seems to fade more and more. The car has brought in as many traffic problems as it has solved. The side effect of mediums seems to be as harmful as their main effects are benificial.

Science has also led to an image of the universe and all that is in it including humans as contrivance of machine. It has detached value from information. In short it has made God and religion irrelevant and increased the gap between science and faith to an almost unbridgeable extent.

On the other hand on behalf of the scientific group it can be said that so far as they are concerned their work is largely value-free except the applied branch and use or misuse is upto the society or its decision-makers.

Be that as it may, fact remains that some answer has to be found out as to how to keep this Frankestein in check so that the civilisation is saved from destruction and the resources are preserved from plumbering to exhaution in forseable future. The publication "Science Education and Ethical Values" has tried to put forward some food for thought through the essays contained in it. The book comprise of a number of essays, by eminent educationists in scientific field, on different aspects of the problem. Reading of the book is bound to set in motion the process of serious thinking on the problem by all concerned and also not so concerned.

It is a collection of eight essays together with two summaries and one report on science education in secondary schools and teacher training institute. The essays can be broadly grouped in two categories: one, general discussion on definition of ethic, interelation of science and metaphysical concepts and society, need for adding values to science, interaction of fact and faith and the other, deal-with problems of introducing ethics and religion in science education.

The first essay describes models of science education. Three models have been discussed, namely, *Product model*—in which students are introduced 'normal science' by a gradual introduction to set problem solutions and techniquies. It is normally assumed that to every question there is one correct answer. It is in the nature of passing on collected information. Teacher students relationship is such that heierachical and the intention or aim is to maximize the flow of collected facts and infomation for teacher to student. In science education conducted on these principles of science, technology and society, studies and ethical reflections may be introduced, but their components have to be justified in utilitarian terms. For example, will they help in the management of R & D, or in resolving ethical dilemmas. The second model, *Inquiry model*—which conveys an idea that is endemically pluralistic and its truth claim is only relative. *Relevance model*—Acquisition of knowledge for the path of collective liberation and personal development is problem solving response to human needs. Here also interaction of science with society and ethics can be integrated in the science education. Finally, the author has left the subject whether ethics should be or can be integrated with science education as an open question.

In the second essay "Religion, values and science education" the author has discussed in what ways religious beliefs in general and Christian beliefs in particular, might be relevant to aspects of Science teaching viz., scientific theories, priorities in scientific research and policy choices involving applied sciences. It has been said ''religious faith is not directly relevant to the analysis of specific scientific theories. The history of church's interference in scientific debate since the time of Copernicus and Galilco has led to a justifiable demand for the autonomy of science." It has been hinted that there are some levels of truth in the scriptures under the garb of metaphors and allegoris. Problems have been suggested for example whether the "Big Bang" theory in astronomy can be interpreted as scientific, support for the doctrine of creation, or is it the steady state theory which postulates uniform processes during an infinite span of time and space. Religion, faith may influence the selection of topics and or on the kinds of concepts or hypothesis but the choice among competing scientific theories must be made by the scientific community alone.

Even though scientific is considered generally value free (by the scientific community) and most forms of basic research scientist is motivated by intellectual curiosity there appears constraints introduced by need for financial support. Ultimately, therefore, selection of problems for research, particularly in applied sciences, are largely determined by the economic interest of industry and political goal of the government which provides fund. Thus, there is need for awareness of the social content of science and the students should be helped to gain such an awareness. The author then states relevance of biblical religion to applied science and technology and mentrous human fulfilment, human nature and individual and social change. The author finds in plural is tie culture and ethical issues a common ground for christians and non-christian causes.

In conclusion the author has put forward some concrete proposals of introducing eithics in science education. History of science and social context of scientific research can give some picture of scientific enterprise going beyond the memorization of formulas.

The third essay "Values, responsibilities and commitments in teaching science" is a lucid discussion how scientific knowledge has detached itself from theological contention and ultimately social ethics and commitment. This has increased the gap between science, faith and values. The facts and information established by science has made metaphysical concept irrelevant. Human being needs meaning in addtion to information.

The overwhelming progress of science and technology in a short span of time and the material benefit coming out of it has conditioned the mankind to materialism with exclusion of all other concepts and meaning. The omission of meaning, purpose and fulfilment of life finds expressions in yearnings of those who feel lost in an age committed to seek solutions of human problems in technology and economics. The author explains that there are two ways to understand the world around us, reduction and holistic.

This essay is an unbiased, lucid and thought provoking piece.

In the fourth essay "Moral development and education the author has discussed moral reasoning and behaviour and their development in individuals. Questening Kohlberg's theory, starting point of which is based on Piaget's model that development from early childhood onwards is not constant but occurs in definable stages. The change from one stage to the next is dependent upon a person's interaction with the environment. In each individual personality there is a cognitive system, a stage of logical reasoning or intelligence which allows it to cope with the environment. The cognitive system is in a certain state of equalibrium, but when this state of equilibrium is lost, then the person streches the cognitive system to assimilate and accommodate the self over more into the environment. Thereby again attaining a cognitive system in equilibrium. Based on expriments carried out by Kohleberg and himself, the author concludes that by giving responsibility in just and fair manner environment and through discussion of congnitive, moral and practical continuation of this environment a person can be led to higher stage of moral development.

In the essay "Reasoning in science and ethics" attempt has been made towards establishing what is ethic. So far as science is concerned its discoveries, convention, announced processes, in short, scientific knowledge can be proved by positive demonstration and will be accepted by everyone who is free, dear-headed and therefore, is objective. But ethics is subjective and no method exists to divide between alternative moral standards. No ethical conclusion can be made to be accepted by all without exception.

Thus it will be unreasonable to say that science and technology have caused all the social and moral problems we have to deal with. Science and technology do not exist independently, they are part of an society and culture.

In the next essay, "Collective and social decision-making : implication for teaching science", the author makes indisputable remarks—science and technology can create ethical and social problems, which can only be resolved by collective decision-making and that, this has to be informed and knowledge and country's survival and economic growth will depend upon decision-making ability of this society. The key points of the essay are to clarify what it means to make a decision regarding social issues related to science and technology and to explore some practical implication for teaching science at secondary school level.

The author has mentioned that the ethical and political nature of scientific enterprise is considered by many to be a myth. Because political, ethical or ideological values influence professional judgment, there would appear to be some kind of communion. The author then explains that science has its own set of values which like a constitution, guide scientists when they devise, for example, competing theories or experimental methodology. Such values and normative constraints are learnt by apprentice scientists and become an important aspect to their disciplinary matrix. By contrast, the social context in which science and technology work is done having reference to ethical, ideological an cultural aspects and has a different kind of values—contextual value. Therefore, science and technology cannot be around to be as value free as some science educators would have us believe.

The author then has made a point that imaginative initiatives alone is not enough for decision making. A number of defects have been cited for such decision-making and hinted at the need for recourse to scientific and knowledge for decision-making. At the same time probleme-solving skill developed in classroom can not be taken as dicision-making ability and has cited examples in support of this view. It is not clear if the author's contention is whether all outside the realm of science and technology should be taught science, or all scientists should be taught politics, economics, management techniques.

It is necessary to mention some question on the subject likely to arise in readers mind. Firstly, how many of those who are decision-makers, throughout the world who has put the world of to-day in the grip of universal greed for wealth and power, belong to scientific or technological community either by profession or by training. Possibly microscopic few. On the other hand, there are decision-makers of other tribes uses or misuses scientific and technological discoveries and invention. Therefore, the need of introducing theorology and ethics in science education is difficult to comprehend.

Secondly, it is not clear how the very real defects in decision-making spelt out, for example, lack of manpower and expertise to assess data, naive view that scientific or technological facts are value free and can objectively and deductively lead to a division on a lack of sufficient political-economic power and technical expertise necessary to ensure a balanced view among adverseries.

Nuclear weapon is not doubt a real threat confronting humanity today but in absence of nuclear weapon men would have fought with clubs and stones, as they have been doing before nuclear energy came to be known. The only valid point is that rate of destruction in that case would be and perhaps could be made good by rate of reproduction.

I occassionally escort a child to the bus stop for his school bus. While listening to the conversation of the children in the age group of five to eight years, I was shocked to hear them exclaim Mercedes, Suzuki, Fiat, as cars pass by. There is a clear tone of relish and longing to own these. They do not talk of the school, of games or play-things. I have even heard them giving expression to their imagination of having a car of this make or the other and mutually competing in imaginary possession. Not that we were better children in our chidhood than these children but then, there were no Mercedes and Fiats in such a large number in those days. It is this craze created by powerful vested interests, motivated by all engulfing greed that has brought this world to such a state as it is today. A century ago by and large industry used to produce which society needed. The motivating factor was profit, and not greed. Now industry decides the product first and generally, the need thereafter, by developing a craze for it though flooding publicity. A child is exposed to this craze creating publicity all the time except when asleep. He is exposed to publicity on way to school, at home, in company with the parents for all products from Nirodh to Pizza to TV to car and what have you.

There is controversy on the definition of ethics. As has been discussed in the book under review it is subjective and any particular contention impossible to be made acceptable to all. Gone are the days of naive acceptance of ethics.

The efficacy of teaching Ethical values leading to moral reasoning appears to be like treating a cancerous sore with tincture iodine and hoping to be cured. On the one hand, the cancerous malady of present day can be least affected by ethical teaching, on the other hand, the quest for search and knowledge of scientific and technological realm can not be briddled by ethical belt. Galelio could not be stiffled by combined religious and political restriction of his time, his finding has been carried forward. The proposition to guide scientific quest by ethical control so as to curb the search and activity in fields considered inhibited by so called ethical standards is like declaring to keep away from the tree bearing fruit of knowledge and likely to meet the same fate as it happend in the biblical legend.

But it must be conceded that the book contains valueable thought provoking material. Different aspects concerning teaching of science, ethics, attitude of scientific community, moral reasoning and behaviour, decision making have been discussed with valuable information and very apt language and expression.

Lastly the price of the book appears exorbitant considering that there are no complicated diagrams or illustrations which goes to increase cost of production.

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